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(54) **Applicator for insertion into a body opening for medical purposes.**

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Description

The present invention concerns an application for insertion into a body opening for hyperthermic treatment of tumors according to the precharacterizing portion of claim 1. The invention is particularly useful as a heating applicator for insertion through the anus into the rectum of a patient for use in hyperthermia treatments, and is therefore described below with respect to this application.

The applicator of the present invention is particularly useful with the catheter and probe described in EP-A-0 246 176.

Hyperthermia is a recognized technique for rendering certain therapeutic treatments to a patient by the application of heat to the portion of the patient's body to be treated. A large number of applicators have been developed for treating cancer, or for other therapeutic purposes such as the treatment of hemorrhoids, as described for example in US-A-4,375,220, 4,312,364, 4,311,154, 4,227,535, 4,186,729, 4,154,246, 4,140,130, 4,016,886, 2,043,083, 2,032,859 and 1,433,286.

European patent 0 139 607, corresponding to US patent 4 601 296 discloses another applicator of this type for insertion into a body opening for medical purposes, which applicator includes an elongated jacket for insertion into the body opening, and a flexible sleeve surrounding the jacket. In the construction described in this patent, the flexible sleeve is inflatable with a coolant to fill the cavity according to the anatomical configuration of the cavity and of the tumour being treated.

An object of the present invention is to provide an applicator of the latter type but having advantages over the construction described in that patent.

According to the present invention, there is provided an applicator of the type described in European patent 0 139 607, characterized according to the characterizing portion of claim 1.

The invention is particularly useful for rendering hyperthermia treatments. For such an application, the applicator further includes a microwave antenna disposed within the jacket, the jacket further including cooling ducts adjacent its outer surface for circulating a cooling fluid therethrough in order to prevent undue heating of the body tissue in direct contact therewith. The balloon, when inflated, thereby also effects efficient cooling of the body tissue in contact with the opposite side of the jacket. The applicator may thus be used for heating tissue directly in contact with the outer face of the applicator, in which case a cooling fluid would not be circulated through the cooling ducts ;
alternatively, the applicator may be used for heating more remotely-located tissue, in which case a cooling fluid would be circulated through the cooling ducts in order to prevent undue heating of the tissue in direct contact with the applicator.

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein :

Fig. 1 is a side elevational view illustrating one form of heating applicator constructed in accordance with the present invention, the sleeve and balloon carried by the applicator being shown in its inflated condition ;

Fig. 2 is a longitudinal sectional view of the applicator of Fig. 1 with the heating element and balloon-sleeve removed ;

Fig. 3 is a transverse sectional view along lines III–III of Fig. 1 ;

Fig. 4 is a diagrammatic view illustrating the formation of the channels in the outer face of the inner sleeve, which channels cooperate with the outer sleeve of the jacket to define the cooling ducts ;

Fig. 5 is an end view, partly in section, of the end fitting in the applicator of Fig. 1 ;

Figs. 5a, 5b and 5c are sectional views along lines a–a, b–b, c–c, respectively, of Fig. 5 ;

and Fig. 6 is a sectional view of the microwave antenna used as the heating element in the applicator of Fig. 1.

The applicator illustrated in the drawings comprises an elongated jacket, generally designated 2, for insertion into a body cavity at the location of the tissue to be heated. The applicator illustrated in Fig. 1 is particularly designed for insertion via the body anus into the rectum for treating this region of the body, although it will be appreciated that the invention could be applied to other body cavities and used for other therapeutic treatments or for diagnostic purposes.

The illustrated applicator includes a heating element in the form of a microwave antenna, indicated by broken lines 4 in Fig. 1 but more particularly illustrated in Fig. 6, generating RF electromagnetic radiation for heating the body tissue. The applicator further includes a disposable sleeve 6, carried by the jacket 2 and integrably formed with a balloon 7 projecting laterally at the distal end of the sleeve. Balloon 7 is inflatable by air or water applied via a tubelet 8 extending through an end fitting 10 externally of the sleeve. The balloon 7 is of generally conical configuration when inflated, having a narrow tip 7a joined to the sleeve 6, and a wide base 7b at its opposite end engageable with the body tissue at one side of the body opening when the balloon is inflated while the applicator is within the body opening.

Antenna 4 is more particularly illustrated in Fig. 6. It is constructed of a coaxial cable including an inner electrical conductor 12 and an outer electrical conductor braid 13 separated from the inner conductor by a dielectric layer 14. The dielectric layer 14 is removed from the end of the coaxial cable to bare the inner conductor 12, and the inner conductor is then covered by

a dielectric layer 15, e.g. glass or ceramic having a dielectric constant of at least 2. The outer conductor braid at the end of the cable is folded back over itself and is separated from the underlying braid by a dielectric layer 16. The outer face of the antenna is then covered by a protective coating 18, as by dipping in a bath of insulating material.

As shown more particularly in Figs. 2 and 3, jacket 2 includes an inner, relatively thick core 20, an outer thin sleeve 22, and a solid tip 24 at the distal end of the applicator. Inner core 20 is formed with an axially-extending bore 26 for receiving the microwave antenna 4, and its outer face is formed with a plurality of axially-extending ribs 20a to define a plurality of recessed channels 28, as more particularly illustrated in Figs. 3 and 4. Channels 28 form, with the outer sleeve 22, a plurality of cooling ducts for circulating a cooling fluid, such as water.

As shown in Fig. 4, the cooling ducts defined by recessed channels 28 extend the complete length of the jacket in a sinuous manner from the cooling fluid inlet 30 at the proximal end of the applicator (left end in Fig. 4, but right end in Figs. 1 and 2) back and forth with respect to the opposite, distal end of the applicator, the water exiting via the water outlet 32 at the proximal end of the applicator.

The solid tip 24 at the distal end of the applicator is formed with an annular recess 34 for receiving the distal ends of the inner core 20 and the outer sleeve 22. The proximal ends of these sleeves are received within a cylindrical recess 36 formed centrally of the end fitting 10.

End fitting 10 is further formed with a central bore 40 for passing the microwave heating antenna 4 therethrough into the bore 26 of the inner core 20. Fitting 10 is further formed with a pair of lateral bores 42, 44 (Figs. 5, 5a) communicating with the cooling ducts 28 for circulating the cooling fluid, (e.g., water) therethrough. Bore 42 is the inlet for the cooling water, and bore 44 is the outlet.

End fitting 10 is formed with a further bore 46 (Fig. 5, 5b) serving as the inlet for admitting air or water to inflate balloon 7 via tubelet 8 received within bore 46 and connected to the balloon. End fitting 10 includes a still further bore 48 (Figs. 5, 5c) for receiving the electrical leads of three thermocouples 50a, 50b, 50c (Fig. 1) which measure the temgerature within the body opening into which the applicator has been inserted.

The inner core 20 is formed, for approximately one-half its circumference, with the ribs 20a defining the cooling ducts 28 ; for the other half of its circumference, the outer face of sleeve 22 is lined with a copper reflector layer 52, as shown in Fig. 3, extending substantially along the complete length of the sleeve, this being at the side of the jacket carrying the inflatable balloon 7. Copper layer 52 reflects the electromagnetic radiation generated by the microwave antenna 4 in the direction away from balloon 7 so that the generated heat is concentrated in the body tissue at the side of the body opening opposite to the balloon.

Thermocouples 50a, 50b, 50c (Fig. 1) are disposed substantially at the outer surface of jacket 2 adjacent to its distal end, and are spaced from each other a slight distance longitudinally of the jacket, as shown in Fig. 1, in order to measure the temperature at these three selected regions of the body cavity in which the applicator is inserted. The electrical conductors to these thermocouples pass axially along the side of the jacket occupied by reflector 52, on the outer face of the reflector as shown at 54a in Fig. 3, to the axial location of the respective thermocouple, and then pass circumferentially along the outer face of the reflector to their respective thermocouple, as shown at 54b in Fig. 3. Reflector 52 thus substantially shields the electrical conductors from the electromagnetic field produced by the antenna.

An insulating layer 56 is applied to insulate electrical conductors 54a, 54b from the reflector 52, and also to insulate the thermocouples 50a-50c from the cooling effect produced by the cooling fluid circulated through the cooling ducts 28. An outer thin protective layer, such as a dipped coating, is applied to the outer face of jacket 2 covering the thermocouples 50a-50c and their electrical conductors 54a, 54b.

The disposable sleeve 6, including the balloon 7 and tubelet 8, is supplied separately and may be applied to the outer face of the applicator 2 just before it is intended to be used. Sleeve 6 is preferably formed integrally with balloon 7 from an elastomer, e.g., rubber latex. For sanitary purposes, the sleeve is disposable for one-time use.

The manner of using the heating applicator illustrated in the drawings will be apparent from the above description. Thus, after a sleeve 6, with its integrally formed balloon 7 has been applied to the applicator, the applicator is inserted into the body opening, for example into the rectum via the anus, while balloon 7 is deflated. When the distal end (left end) of the applicator is in proper position within the body opening, balloon 7 is inflated by pressurized air or water applied via bore 46 in end fitting 10, and tubelet 8. The inflation of the balloon causes it to firmly press the opposite side of the applicator against the body tissue in the opening. Electrical current is then applied to the microwave antenna 4 in order to generate a microwave field for heating the body tissue opposite to balloon 7, this energy being concentrated by reflector 52. During the heating of the body tissue, water may be circulated via the cooling ducts 28 to cool the outer surface of the jacket, while the temperature within the body opening is measured by thermocouples 50a, 50b, 50c.

It will thus be seen that the inflation of balloon 7 at the distal end of the applicator displaces the

applicator laterally within the body opening, thereby firmly pressing the side thereof through which the microwave radiation is transmitted (namely the side opposite to that occupied by balloon 7 and reflector 52) firmly against the body tissue. This fixes the position of the jacket, and thereby of the microwave antenna 4, within the body opening, and also conforms the pressed body tissues to the shape of the jacket at the opposite side of reflector 52.

The inflation of balloon 7 also enhances the cooling effect produced by the water circulated through the cooling ducts 28, thereby efficiently cooling the body tissue in direct contact with the applicator. This permits the application of relatively large amounts of heat to relatively remote tissue without undue discomfort to the subject, or heat damage to the adjacent tissue lining the body cavity receiving the applicator.

If, however, it is desired to heat the adjacent tissue lining the body cavity received the applicator, the cooling water would not be circulated through the cooling ducts 28. The described applicator may therefore be used for heating relatively remote tissue, in which case cooling water would be circulated through cooling ducts, or adjacent tissue, e.g., tissue, lining the cavity receiving the applicator, in which case there would be no circulation of cooling fluid through the cooling ducts.

The provision of the thermocouples 50a-50c adjacent to the outer face of the jacket but thermally insulated from the cooling ducts 28, and the provision of the balloon pressing the thermocouples against the body tissue, produce a more precise measurement of the temperature of the body tissue being heated by the applicator. Moreover, by passing the electrical conductors to the thermocouples axially along the outer face of reflector 52 (conductor sections 54a, Fig. 3) and then circumferentially (conductor sections 54b, Fig. 3) to their respective thermocouples 50a-50c, the measurements produced by the thermocouples are substantially insensitive to the heat and electromagnetic field produced by the microwave antenna, thereby further increasing the precision of the temperature measurements of the body tissue.

Claims

1. An applicator for insertion into a body opening for hyperthermic treatment of tumours which applicator includes a probe having an elongated jacket (2) and a sleeve (6) received on the distal end of said jacket (2) to be inserted into the body in the vicinity of a tumour to be treated, the probe comprising an integrally formed housing having cavities wherein are disposed a forward heating portion containing a radio emitting antenna (4) producing an overall directional radiation pattern and a conduit system (8,28) for the passage of a cooling fluid adjacent the outer surface thereof for cooling of the tissue lying adjacent the probe and a rearward portion being arranged to be of significantly less cross sectional area than the forward portion, the probe also including temperature sensing means for indicating the temperature at the surface of the probe and automatic temperature control means for control operation of the automatic response thereto and to terminate operation of the antenna in response of overheating of the adjacent tissue, the sleeve (6) being partly inflatable by a fluid to press the opposite side of the jacket (2) and sleeve (6) facing away from its inflatable part (7) laterally against the tissue of the body opening, thereby to fix the position of the jacket (2) within the body opening and to conform the pressed body tissue to the shape of said opposite side of the jacket (2) and sleeve (6) characterized in that said flexible sleeve (6) includes a balloon (7) integrally formed with and joined to the flexible sleeve (6) at one side of the sleeve and jacket, said balloon occupying only the distal end of said flexible sleeve (6) and said balloon (7) is of generally conical configuration when inflated having a narrow tip (7a) at one end where joined to said sleeve and a wide base (7b) at the opposite end for engagement with the body tissue at said opposite side of the jacket (2), said jacket (2) including an inner relatively core (20), a sleeve (22) and a tip (24), said inner core being formed for approximately one-half its circumference with ribs (20a) defining cooling ducts (28) and for the other half of its circumference, the outer face of sleeve (22) is lined with a copper reflector layer (52) extending substantially along the complete length of the sleeve, at the side of the jacket carrying the inflatable balloon (7).

2. The applicator according to claim 1, characterized in further including a tubelet (8) extending externally of said flexible sleeve (6) to said balloon (7) for inflating and deflating same.

3. The applicator according to any one of claims 1 and 2 characterized in further including a microwave antenna (4) disposed within said jacket (2), said cooling ducts (28) within said jacket (2) adjacent its outer surface circulating a cooling fluid therethrough in order to prevent undue heating of the body tissue in direct contact therewith, said balloon (7), when inflated, thereby also effecting efficient cooling of the body tissue in contact with said opposite side of the jacket.

4. The applicator according to claim 3, characterized in that said reflector (52) within said jacket at said one side reflects the microwave energy produced by said microwave antenna (4) through said opposite side, and for concentrating the energy to a selected region of the body tissue at said opposite side of the jacket (2).

5. The applicator according to claim 4, characterized in that said microwave antenna (4) includes an inner electrical conductor (12), a layer of dielectric

thereover (14), serving as a dielectric loading, and an outer electrical conductor (13) in the form of a braid ; the outer end of said outer electrical braid (13) being folded back over itself at one end of the antenna and being dielectrically separate from the underlying electrical braid by another dielectric layer (16), thereby forming a dielectric loaded antenna in which the folded back portion of the electrical braid serves as an RF choke supressing electromagnetic interference.

6. The applicator according to any one of claims 1-5, characterized in that said jacket (2) further includes a temperature measuring device (50a-50c) adjacent to the outer surface of said opposite side of the jacket (2), said balloon (7), when inflated, thereby also effecting efficient measurment of the temperature of the body tissue in contact with said opposite side of the jacket.

7. The applicator according to claim 6, characterized in that said temperature device (50a-50c) includes an electrical conductor having a first section (54a) passing axially of the jacket (2) and reflector (52) along the face of the reflector opposite to that facing the RF heating element so as to be substantially shielded therefrom by the reflector, and a second section (54b) passing circumferentially of the jacket (2) from its first section (54a) shielded by the reflector (52) to the temperature measuring device (50a, 50b, 50c).

8. The applicator according to either of claims 6 or 7 characterized in that there are a plurality of said temperature measuring devices (50a, 50b, 50c) spaced axially of said jacket (2), each of said temperature measuring devices being a thermocouple attached to the outer face of the jacket (2) and thermally insulated therefrom.

Patentansprüche

1. Applikator zum Einführen in eine Körperöffnung zur hyperthermischen Behandlung von Tumoren, wobei der Applikator eine Sonde aufweist, die einen langgestreckten Mantel (2) und eine Hülse (6) hat, die an dem in den Körper in die Nähe eines zu behandelnden Tumors einzuführenden distalen Endes des Mantels (2) aufgenommen ist, wobei die Sonde ein angeformtes Gehäuse aufweist, das Hohlräume hat, in denen ein vorderer Heizteil angeordnet ist, der eine Hochfrequenz aussendende Antenne (4) enthält, die ein Gesamtrichtstrahlungsdiagramm erzeugt, und ein Leitungssystem (8, 28) zum Hindurchleiten eines Kühlfluids benachbart zu der äußeren Oberfläche desselben zum Kühlen des Gewebes, das benachbart zu der Sonde liegt, und ein hinterer Teil, der so ausgebildet ist, daß er eine wesentlich kleinere Querschnittsfläche als der vordere Teil hat, wobei die Sonde außerdem eine Temperaturabfühleinrichtung hat zum Anzeigen der Temperatur an der Oberfläche der Sonde und eine automatische Temperatursteuereinrichtung zum Steuern des Betriebs des automatischen Ansprechens auf diese und zum Beendigen des Betriebs der Antenne bei Überhitzung des benachbarten Gewebes, wobei die Hülse (6) durch ein Fluid teilweise aufpumpbar ist, um die entgegengesetzte Seite des Mantels (2) und der Hülse (6), die von ihrem aufpumpbaren Teil (7) abgewandt ist, seitlich gegen das Gewebe der Körperöffnung zu drücken und dadurch die Position des Mantels (2) innerhalb der Körperöffnung zu fixieren und das unter Druck gesetzte Körpergewebe der Form der entgegengesetzten Seite des Mantels (2) und der Hülse (6) anzupassen, dadurch gekennzeichnet, daß die flexible Hülse (6) einen Ballon (7) aufweist, der an der flexiblen Hülse (6) an einem Ende der Hülse und des Mantels angeformt und mit der Hülse verbunden ist, wobei der Ballon nur das distale Ende der flexiblen Hülse (6) einnimmt und wobei der Ballon (7) eine insgesamt konische Konfiguration hat, wenn er aufgepumpt ist, mit einer schmalen Spitze (7a) an einem Ende, wo er mit der Hülse verbunden ist, und mit einer breiten Basis (7b) an dem entgegengesetzten Ende zur Anlage an dem Körpergewebe auf der entgegengesetzten Seite des Mantels (2), wobei der Mantel (2) einen inneren, relativ dicken Kern (20), eine Hülse (22) und eine Spitze (24) aufweist, wobei der innere Kern auf ungefähr der Hälfte seines Umfangs mit Rippen (20a) versehen ist, die Kühlkanäle (28) bilden, und wobei auf der anderen Hälfte seines Umfangs die äußere Seite der Hülse (22) mit einer Kupferreflektorschicht (52) verkleidet ist, die sich im wesentlichen über die volle Länge der Hülse auf der Seite des Mantels erstreckt, welche den aufpumpbaren Ballon (7) trägt.

2. Applikator nach Anspruch 1, gekennzeichnet durch ein Röhrchen (8), das sich außerhalb der flexiblen Hülse (6) zu dem Ballon (7) erstreckt, um denselben aufzupumpen und zu entleeren.

3. Applikator nach einem der Ansprüche 1 und 2, gekennzeichnet durch eine Mikrowellenantenne (4), die in dem Mantel (2) angeordnet ist, wobei in den Kühlkanälen (28) innerhalb des Mantels (2) benachbart zu dessen äußerer Oberfläche ein Kühlfluid zirkuliert, um eine übermäßige Erhitzung des Körpergewebes zu verhindern, das mit ihm in direktem Kontakt ist, wobei der Ballon (7), wenn er aufgepumpt ist, dadurch auch eine wirksame Kühlung des Körpergewebes bewirkt, welches mit der entgegengesetzten Seite des Mantels in Kontakt ist.

4. Applikator nach Anspruch 3, dadurch gekennzeichnet, daß der Reflektor (52) innerhalb des Mantels auf der einen Seite die Mikrowellenenergie, welche durch die Mikrowellenantenne (4) erzeugt wird, durch die entgegengesetzte Seite reflektiert und die Energie auf ein ausgewähltes Gebiet des Körpergewebes auf der entgegengesetzten Seite des Mantels (2) konzentriert.

5. Applikator nach Anspruch 4, dadurch gekennzeichnet, daß die Mikrowellenantenne (4) einen inneren elektrischen Leiter (12) aufweist, eine darüber angeordnete dielektrische Schicht (14), die als dielektrische Belastung dient, und einen äußeren elektrischen Leiter (13) in Form einer Umflechtung, wobei das äußere Ende der äußeren elektrischen Umflechtung (13) an einem Ende der Antenne zurückgeschlagen und von der darunter gelegenen elektrischen Umflechtung durch eine weitere dielektrische Schicht (16) dielektrisch getrennt ist, wodurch eine dielektrisch belastete Antenne gebildet ist, bei der der zurückgeschlagene Teil der elektrischen Umflechtung als HF-Drossel dient, die elektromagnetische Störung unterdrückt.

6. Applikator nach einem der Ansprüche 1-5, dadurch gekennzeichnet, daß der Mantel (2) weiter eine Temperaturmeßvorrichtung (50a-50c) benachbart zu der äußeren Oberfläche der entgegengesetzten Seite des Mantels (2) aufweist, wodurch der Ballon (7), wenn er aufgepumpt ist, auch eine wirksame Messung der Temperatur des Körpergewebes bewirkt, das mit der entgegengesetzten Seite des Mantels in Kontakt ist.

7. Applikator nach Anspruch 6, dadurch gekennzeichnet, daß die Temperaturvorrichtung (50a-50c) einen elektrischen Leiter enthält, der einen ersten Abschnitt (54a) hat, der den Mantel (2) und den Reflektor (52) längs der Seite des Reflektors, die zu der dem HF-Heizelement zugewandten entgegengesetzt ist, axial passiert, so daß er davon durch den Reflektor im wesentlichen abgeschirmt ist, und einen zweiten Abschnitt (54b), der in Umfangsrichtung des Mantels (2) von dessen erstem Abschnitt (54a), welcher durch den Reflektor (52) abgeschirmt ist, zu der Temperaturmeßvorrichtung (50a, 50b, 50c) führt.

8. Applikator nach Anspruch 6 oder 7, dadurch gekennzeichnet, daß eine Anzahl der Temperaturmeßvorrichtungen (50a, 50b, 50c) vorgesehen ist, die in axialem Abstand längs des Mantels (2) angeordnet sind, wobei jede Temperaturmeßvorrichtung ein Thermoelement ist, das an der äußeren Seite des Mantels (2) befestigt und davon thermisch isoliert ist.

Revendications

1. Applicateur pour insertion dans un orifice corporel, destiné au traitement hyperthermique de tumeurs, l'applicateur comprenant une sonde munie d'une gaine allongée (2) et d'un manchon (6) qui vient se loger sur l'extrémité distale de la gaine (2) et qui est destiné à venir s'insérer dans le corps à proximité d'une tumeur à traiter, la sonde comprenant un logement faisant partie intégrante de cette dernière et dans lequel sont pratiquées des cavités dans lesquelles viennent se loger une portion antérieure de chauffage contenant une antenne (4) émettant à haute fréquence et générant un diagramme de rayonnement multidirectionnel, un système de conduits (8, 28) destinés au passage d'un fluide réfrigérant en position adjacente à la surface externe de la sonde dans le but de refroidir le tissu disposé en position adjacente à la sonde, ainsi qu'une portion arrière dont la section transversale est conçue pour être essentiellement inférieure à celle de la portion antérieure, la sonde comprenant également des moyens palpeurs de température destinés à indiquer la température régnant à la surface de la sonde, ainsi qu'un moyen automatique de réglage de température destiné à commander la mise en oeuvre de la réponse automatique à la mesure de température et destiné à interrompre la mise en service de l'antenne en réponse à une surchauffe du tissu adjacent, le manchon (6) pouvant être partiellement gonflé à l'aide d'un fluide dans le but de presser le côté de la gaine (2) et du manchon (6) opposé à à sa partie gonflable (7), latéralement contre le tissu de l'orifice corporel, dans le but de fixer ainsi la position de la gaine (2) au sein de l'orifice corporel et pour que le tissu corporel pressé épouse la forme de ce côté opposé de la gaine (2) et du manchon (6), **caractérisé en ce que** le manchon flexible (6) comprend un ballon (7) faisant intégralement partie du manchon flexible (6) et étant joint à ce dernier d'un côté du manchon et de la gaine, le ballon occupant uniquement l'extrémité distale du manchon flexible (6), étant généralement de configuration conique lorsqu'il est gonflé et étant muni d'une pointe étroite (7a) à une extrémité où il est joint au manchon et d'une base large (7b) à son extrémité opposée, destinée à venir se mettre en contact avec le tissu corporel du côté opposé de la gaine (2), la gaine (2) comprenant une âme relative interne (20), un manchon (22) et une pointe (24), l'âme interne étant constituée sur approximativement la moitié de sa circonférence par des nervures (20a) définissant des conduits (28) pour réfrigérant et, sur l'autre moitié de sa circonférence, la face externe du manchon (22) est recouverte d'une couche réfléchissante en cuivre (52) s'étendant essentiellement sur toute la longueur du manchon du côté de la gaine supportant le ballon gonflable (7).

2. Applicateur selon la revendication 1, **caractérisé en ce qu'**il comprend, en outre, un petit tuyau (8) qui s'étend à l'extérieur du manchon flexible (6) en direction du ballon (7), destiné à gonfler et à dégonfler ce dernier.

3. Applicateur selon l'une quelconque des revendications 1 et 2, **caractérisé en ce qu'**il comprend, en outre, une antenne à hyperfréquence (4) disposée au sein de la gaine (2), les conduits (28) pour réfrigérant disposés au sein de la gaine (2) en position adjacente à la surface externe de ce dernier mettant en circulation un fluide réfrigérant dans le but d'empêcher un réchauffement excessif du tissu corporel se trouvant en contact direct avec la gaine, le ballon (7), lorsqu'il

est gonflé, procurant ainsi un refroidissement efficace du tissu corporel qui se trouve en contact avec le côté opposé de la gaine.

4. Applicateur selon la revendication 3, **caractérisé en ce que** le réflecteur (52) disposé au sein de la gaine sur ce premier côté réfléchit l'énergie à haute fréquence produite par l'antenne à hyperfréquence (4) en direction du côté opposé, afin de concentrer l'énergie sur une zone sélectionnée du tissu corporel du côté opposé de la gaine (2).

5. Applicateur selon la revendication 4, **caractérisé en ce que** l'antenne à hyperfréquence (4) comprend un conducteur électrique interne (12), une couche de diélectrique (14) disposée par-dessus cette dernière et faisant office de charge diélectrique, ainsi qu'un conducteur électrique externe (13) sous forme d'une tresse ; l'extrémité externe de la tresse électrique externe (13) étant repliée sur elle-même à une extrémité de l'antenne et étant diélectriquement séparée de la tresse électrique sous-jacente, par l'intermédiaire d'une autre couche diélectrique (16), constituant ainsi une antenne à charge diélectrique dans laquelle la portion repliée de la tresse électrique sert de bobine de réactance pour la haute fréquence, supprimant ainsi l'interférence électromagnétique.

6. Applicateur selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** la gaine (2) comprend, en outre, un dispositif de mesure de température (50a-50c) en position adjacente à la surface externe du côté opposé de la gaine (2), le ballon (7), lorsqu'il est gonflé, procurant ainsi une mesure efficace de la température du tissu corporel, qui se trouvent en contact avec le côté opposé de la gaine.

7. Applicateur selon la revendication 6, **caractérisé en ce que** le dispositif de température (50a-50c) comprend un conducteur électrique muni d'une première section (54a) passant en position axiale de la gaine (2) et du réflecteur (52), le long de la face du réflecteur opposée à celle faisant face à l'élément de chauffage à haute fréquence, de façon à en être essentiellement protégée par le réflecteur, et d'une seconde section (54b) passant circonférentiellement autour de la gaine (2) à partir de la première section (54a) protégée par le réflecteur (52) en direction du dispositif de mesure de température (50a, 50b, 50c).

8. Applicateur selon l'une quelconque des revendications 6 ou 7, **caractérisé en ce qu'**on prévoit une série de dispositifs de mesure de température (50a, 50b, 50c) axialement écartés de la gaine (2), chacun des dispositifs de mesure de température étant constitué d'un thermocouple fixé à la face externe de la gaine (2) et thermiquement isolé de cette dernière.

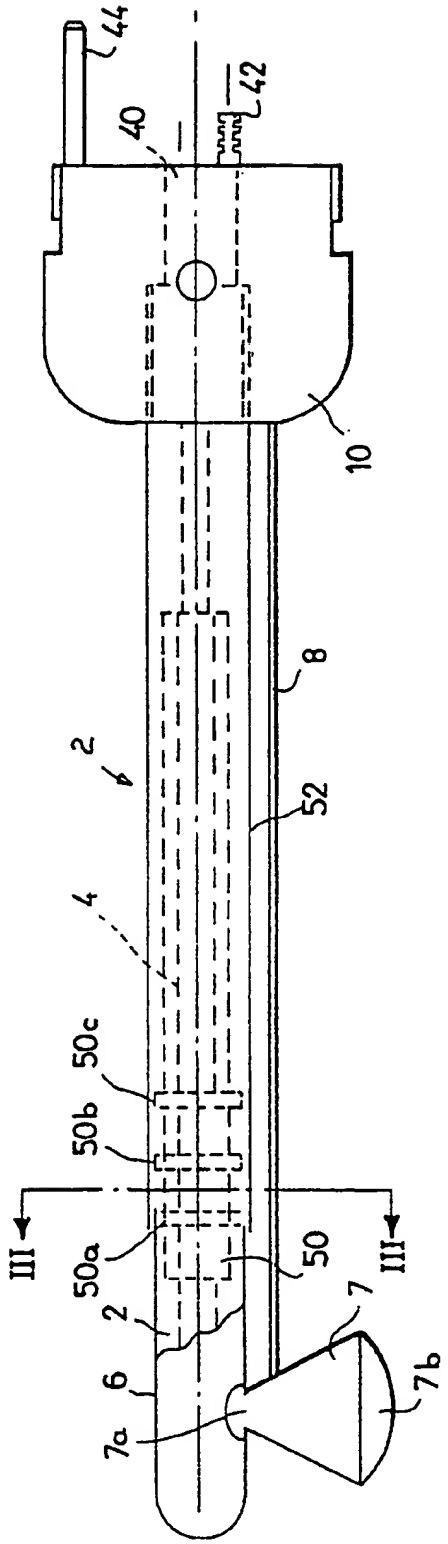

44
42
40
10
8
2
52
4
50c
50b
III
50a
50
III
2
7
6
7b
7a

FIG.1

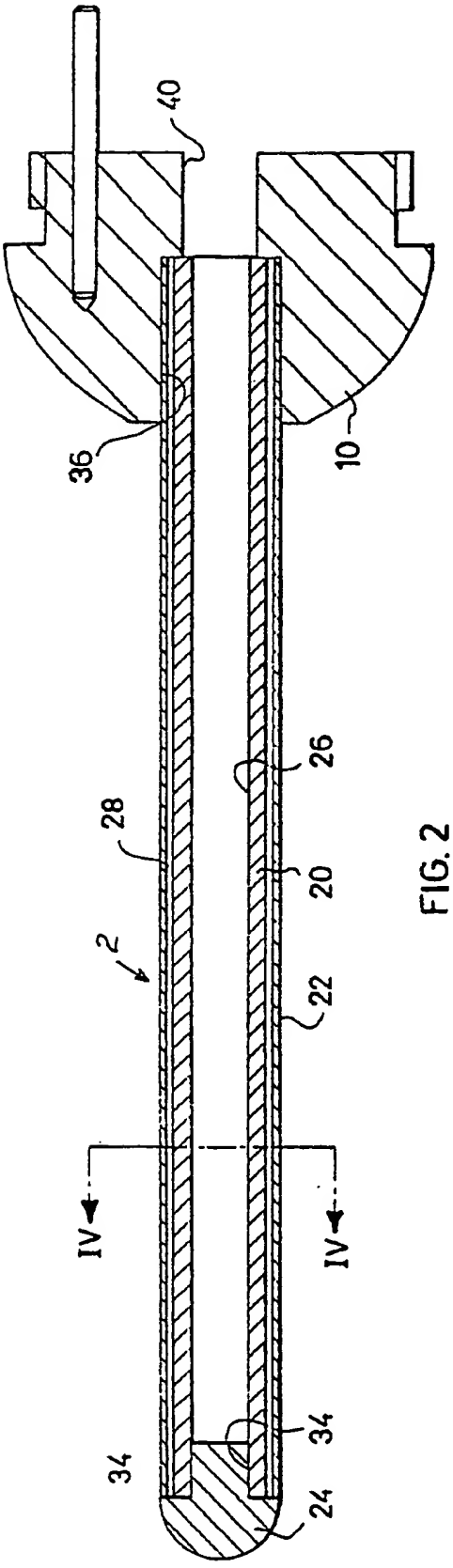

40
36
10
26
28
20
2
22
IV
IV
34
34
24

FIG. 2

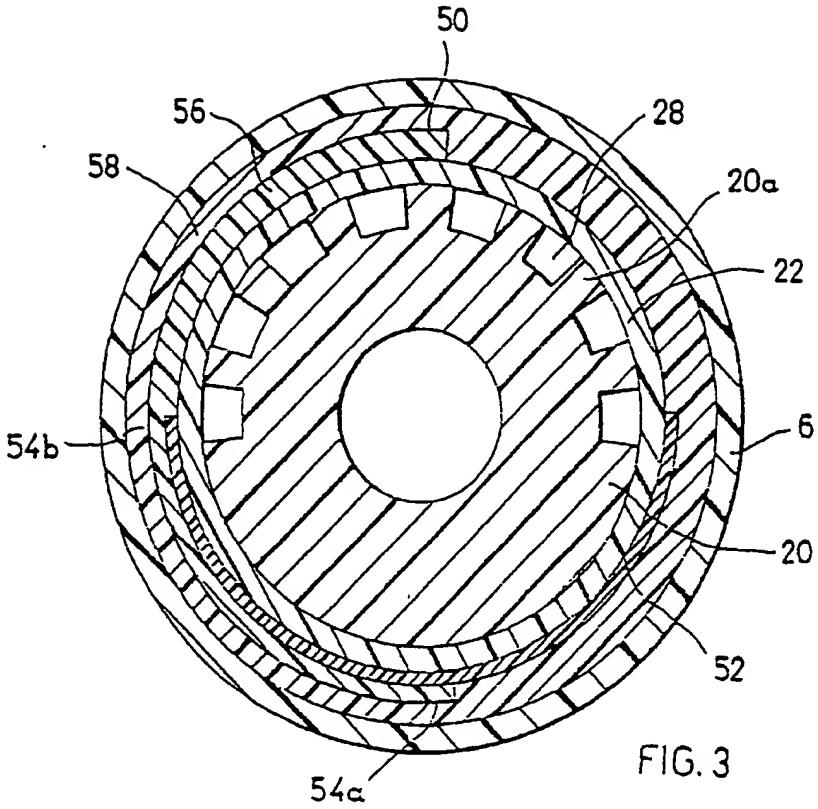


FIG. 3

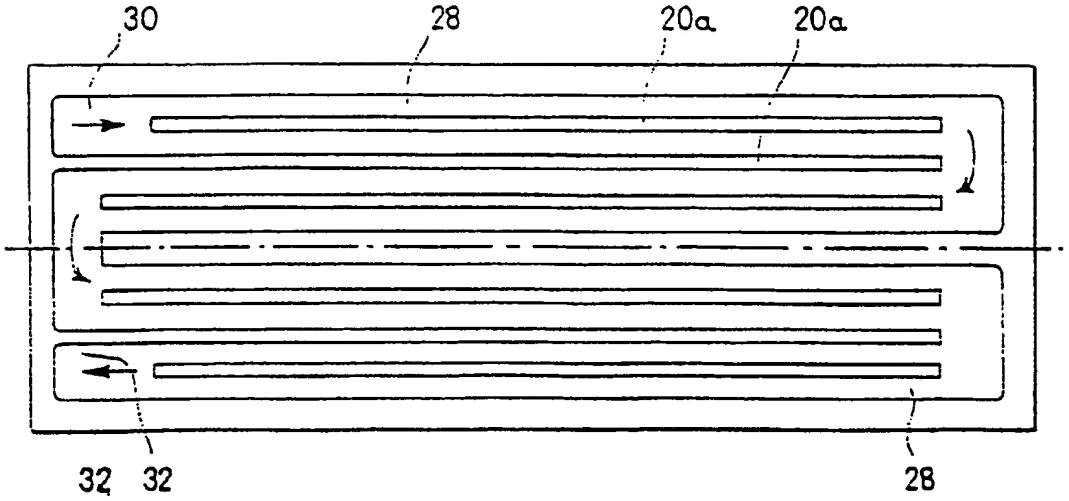
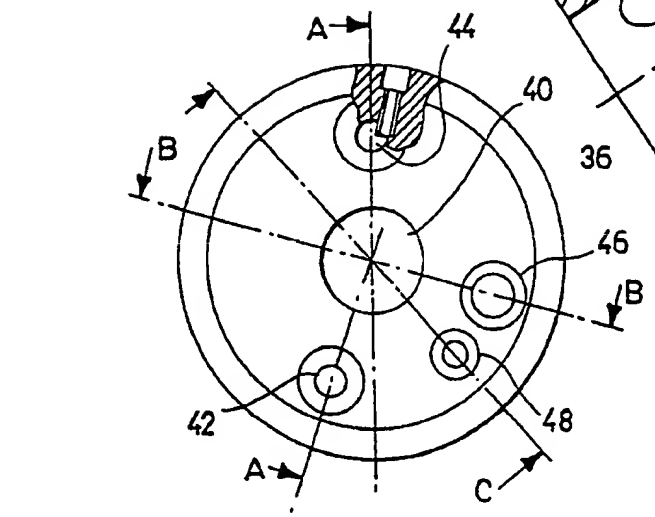


FIG. 4

FIG 5



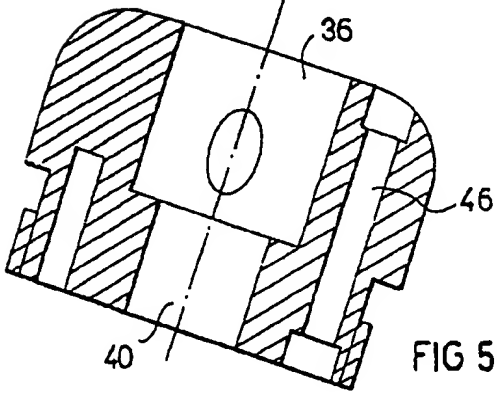


FIG 5b

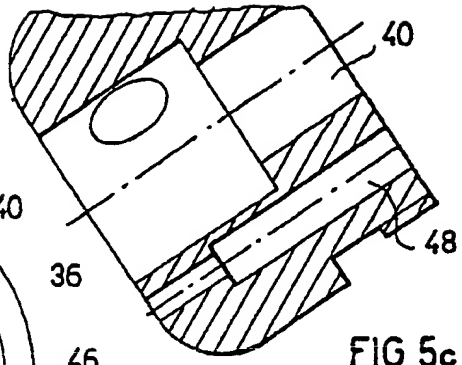


FIG 5c

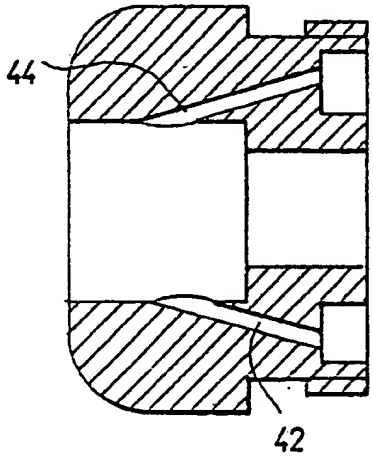


FIG 5a

FIG. 6